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MOST FREQUENTLY VIOLATED AVIATION PROCEDURES (VOLUME I)

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MOST FREQUENTLY VIOLATED AVIATION PROCEDURES

EXECUTIVE SUMMARY

Requirement:

This research was conducted to identify the most frequently violated procedures causing aviation accidents, to determine why they were not complied with, and to recommend actions to correct the underlying causes of these violations. The corrective actions would, as a minimum, address the manner in which the procedure is written and presented in hard copy form, the degree and sufficiency with which the procedure is being taught in school and unit training, and the sufficiency of supervision and accountability emphasis placed on the procedure in unit operations. In this way, the probability of procedural violations would be decreased, resulting in fewer accidents and a savings in personnel and equipment and an increase in overall war-fighting capability.

Procedures:

To identify the most frequently violated procedures causing Army aviation accidents, a large sample (484 cases) of aviation accidents attributed to human error was systematically reviewed to verify that human error was a cause factor in each accident, to identify the specific task being performed by the crewmember committing the error, and to identify the category of human performance error from a taxonomy provided by the U.S. Army Safety Center (USASC). For each task and associated error, the researchers also identified the aircrew training manual (ATM), the specific task number, and standard governing correct performance of the task. In those cases where an ATM did not adequately govern performance, the researchers identified a non-ATM procedure, when applicable. Finally, the systemic source(s) causing each error was identified.

The systemic sources for the errors involved in the 15 most consequential violated procedures were then analyzed to determine common problem areas and to develop interim recommendations for corrective action. An in-depth analysis package was developed for each leading violated procedure. A computerized data base was constructed which provided a record of each accident case involved in the top 15 rotary wing ATM procedures violated. Information pertaining to the accident, the personnel and equipment involved, and all the components of the in-depth analysis package are included in this data base. An analysis of the two most dominant problem areas identified in the accident data, scanning errors, and crew coordination failures was conducted to determine the types of errors experienced by ATM task, aircraft type, and period of day, including night vision device (NVD) usage. The interim recommendations were refined based on this analysis.

Findings:

Overall, the five most frequently occurring errors involved improper monitoring, poor

decisions, improper control actions, inadequate inspections, and inadequate communications. Together, they accounted for 79% of the total number of identified errors. Two categories, improper monitoring and poor decision making accounted for 50% of the total errors. The most frequently reported systemic cause category for the errors was "unknown or insufficient information" which accounted for over 24% of the causes. Other frequently identified causes included inadequate attention, overconfidence, inexperience, inadequate unit training, and improper motivation.

In developing the in-depth analysis packages for the top 15 rotary wing violated procedures, two problem areas were dominant: monitoring errors caused primarily by inadequate attention which were defined as scanning errors and some planning, decision, and communication errors which were defined as crew coordination failures. Together, these two problem areas accounted for 46% of the total number of errors involved in the top 15 violated procedures. Inadequate attention was cited as the cause for almost 71% of the monitoring errors within this sample versus 59% for all 402 cases. A detailed analysis of these problem areas uncovered three different types of scanning errors and five of six crew coordination failures previously defined by the USASC.

The leading type of crew coordination failure was the failure of crewmembers not on the controls to offer assistance or information that was needed or had been previously requested by the crewmember on the controls. This and other types of crew coordination failures occurred more often in utility helicopters than in other types, while cargo helicopters had a much lower incidence.

Both of these problem areas have been previously identified by the U.S. Army Aviation Center (USAAVNC) and are being addressed through publications revisions and training program modifications. The in-depth analysis packages contained in volume 2 of this study provided detailed information pertaining to the specific step or part of each violated procedure and the causes of the violations which should prove useful during revision of the ATMs and their supporting references. This information will also benefit training developers, institutional and unit trainers, and evaluators in the formulation and execution of training programs.

The ATM tasks associated with flight close to the earth's surface adequately address the requirement to remain clear of obstacles and the supporting references provide sufficient guidance about scanning and obstacle-avoidance techniques. However, the methods of imparting this information during institutional training and the degree of emphasis placed on the techniques and teamwork required to optimize crewmember scanning effectiveness do not appear to be standardized or effective.

Utilization:

The indepth analysis packages will be provided to several elements of the USAAVNC including the Aviation Training Brigade (ATB), the Directorate of Tactics and Simulation (DOTS), the Directorate of Training and Doctrine (DOTD), and the Directorate of Evaluation and Standardization (DES) to support specific Night Aviation Council of Colonels actions.

Recommendations are also proposed to reduce the number of unexplained errors, improve the overall quality of accident reports, and consider further research to examine, in detail, the frequently committed decision errors to determine commonality of error types, trends with respect to assessing different types of risk, and recurring causes of these judgmental errors.

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INTRODUCTION

U. S. Army Safety Center statistics have shown that since 1980, human error has been a causal factor in approximately 80% of Army aviation accidents. Many of these errors involve non-compliance with safe operating procedures. Previous reviews of accident reports indicate that some of these procedures are frequently violated. A comprehensive, systematic identification of the specific procedures that are frequently violated, including the precise steps or parts of the procedure and the reasons for non- compliance would provide valuable information for the development of recommendations for actions to correct the underlying causes of the procedural violations.

This research was conducted to identify the most frequently violated procedures causing aviation accidents, to determine why they were not complied with, and to recommend actions to correct the underlying causes of these violations. The corrective actions would, as a minimum, address the manner in which the procedure is written and presented in hard copy form, the degree and sufficiency with which the procedure is being taught in school and unit training, and the sufficiency of supervision and accountability emphasis placed on the procedure in unit operations. In this way, the probability of procedural violations would be decreased, resulting in fewer accidents and a savings in personnel and equipment and an increase in overall war fighting capability.

METHOD

To identify the most frequently violated procedures causing Army aviation accidents, all Class A through Class C aviation accidents (484 cases) attributed to human error for Fiscal Year (FY) 84 through FY89 were systematically reviewed to: verify that human error was a cause factor in each accident identify the specific task being performed by the crewmember committing the error and identify the category of human performance error from a taxonomy provided by the USASC (appendix A). For each task and associated error, the researchers also identified the ATM, specific task number, and the standard govering correct performance of the task. In those cases where an ATM did not adequately govern performance, the researchers identified a non-ATM procedure, when applicable. Finally, the systemic source(s) causing each error was identified.

A data recording form (appendix B) was developed and used to document specific information about each accident case. Each accident case was analyzed independently by two former Army aviators, formally trained and highly experienced in conducting Army aircraft accident investigations, who resolved any differences between reviews before entering the data into a computerized data base. Matrices for fixed and rotary wing aircraft were developed for each violated procedure which displayed the overall task or activity being performed, the specific step or part of the procedure governing correct performance of that task, the errors relating to those specific steps or parts, and the systemic sources for the errors. The most frequently violated procedures, initially ranked by frequency of violation occurrence, were further internally prioritized by evaluating each procedure in terms of frequency of violation occurrence, total accident cost, number of fatalities, and number of injuries. A percentage was calculated for each of these parameters, and the 15 most frequently violated procedures were ranked using an average percentage value of all four parameters. In this way, violated procedures with a low relative frequency of occurrence within the top 15 procedures but with more significant impact on combat effectiveness in terms of lost dollars, equipment, and personnel were ranked above those more frequently occurring procedures having less severe consequences. Efforts could then be concentrated on correcting the underlying causes of the procedural violations with the biggest payoff to the Army. With USASC approval, the leading 15 violated procedures (all rotary wing ATM procedures) were identified and subjected to further analysis.

The systemic sources for the errors involved in the 15 most violated procedures were then analyzed to determine common problem areas and to develop interim recommendations for corrective action. An in-depth analysis package was developed for each leading violated procedure. This package consisted of three components. The first included a matrix displaying the frequency of task errors by systemic sources. The second included a table identifying the standard, condition, description, etc., governing correct performance for each procedure violated; the specific steps or parts of the procedure that were not complied with; the category of human performance error committed; and the sytemic source(s) causing each error. Finally, the package included a table of linking statements for each procedure identified in the first table. Each linking statement provides a synopsis of the violation and systemic failure by describing the error committed, its systemic source(s), and other contextual/pertinent circumstances involved in the accident. The linking statements are organized by the condition, standard, description, note, or consideration section of each ATM task; the step or part violated; the type of error committed; and contributing system failure.

A computerized data base, compatible with dBase IV, was constructed which provides a record of each accident case involved in the top 15 rotary wing ATM procedures violated. Information pertaining to the accident, the personnel and equipment involved, and all the components of the indepth analysis package are included in this data base. An analysis of the two most dominant problem areas identified in the accident data, scanning errors, and crew coordination failures was conducted to determine the types of errors experienced by ATM task, aircraft type, and period of day, including NVD usage. The interim recommendations were refined based on this analysis.

RESULTS

General

All Class A through Class C Army aviation human error accidents, inclusive of FY84 through FY89, were reviewed for this study. Of the 484 accident cases analyzed, 82 cases (17%) were rejected for the reasons shown in table 1. Almost half of these accident cases (40 of 82) contained no supporting evidence for human error having contributed to the accident even though they were coded as human error accidents in the Army Safety Management Information System (ASMIS). Several of these cases involved materiel failure for which the USASC added an error on the part of design or engineering personnel, manufacturing or rework personnel, or some Department of Army or Department of Defense level commander.

Table 1 - FY84 - 89, Army Aviation Human Error Accidents (Class A-C) Reasons for Rejected Accident Cases

Total Accidents Reviewed	484
Accidents Rejected	82
Preliminary Information	25
No Human Error	40
Insufficient Information	12
No Aviation Crew Error	5
Total Accidents in Data Base	402

Of the 402 accident cases remaining for analysis, 369 (92%) involved rotary wing aircraft, while the remaining 33 (8%) involved fixed wing aircraft. The distribution of costs, fatalities, and injuries was also generally consistent with these ratios. Of the 650 total number of human errors verified, 429 (66%) involved violations of ATM procedures while 221 (34%) involved violations of non-ATM procedures. The ratio between violated ATM and non-ATM procedures was similar for the accidents involving rotary wing aircraft (65% to 35%) but was slightly higher for accidents involving fixed wing aircraft (78% to 22%). Table 2 shows the distribution of the accident cases including their costs to the Army in terms of dollars, fatalities, and injuries; the number of human errors across each accident classification; and the violated ATM and non-ATM procedures across aircraft categories (rotary and fixed wing) within the data sample.

Table 2 - FY84-89, Army Aviation Human Error Accidents (Class A-C) Accident Case Data Distributed Across Aircraft Categories

	Total	Rotary Wing	Fixed Wing
Number of Usable Cases	402	369	33
Total Cost	$292,234,720	$279,333,455	$12,901,265
Total Fatalities	147	131	16
Total Injuries	387	374	13
Class A Accidents	337	324	13
Class B Accidents	39	39	0
Class C Accidents	11	11	0
Total Human Errors Verified*	650	604	46
Human Errors in Class A Accidents	225	214	11
Human Errors in Class B Accidents	81	75	6
Human Errors in Class C Accidents	344	315	29
Human Errors Violating ATM Tasks	429	393	36
Human Errors Violating Non-ATM Tasks	221	211	10

*An accident may be caused by more than one human error.

Human Performance Errors and their Causes

All 11 categories of human performance error and 19 of the 23 categories of system inadequacies (systemic causes of errors) provided by the USASC were cited in the 402 human error accident cases. As expected, several categories of system inadequacies associated with material failures were not represented. See appendix A for definitions of the human error and system inadequacy categories. The tables in Appendix C, tables 1-3 show the distribution of the errors and their causes for all 402 accident cases and for the rotary and fixed wing accident cases separately.

Overall, the five most frequently occurring errors involved improper monitoring, poor decisions, improper control actions, inadequate inspections, and inadequate communications. Together, they accounted for 79% of the total number of identifed errors. Two categories, improper monitoring (n = 181) and poor decision making (n = 145), accounted for 50% of the total errors. These frequently occurring error types were also consistent across rotary and fixed wing accidents.

The most frequently reported systemic cause category for the errors was "unknown or insufficient information" which accounted for over 24% of the total causes. Other most frequently identified causes included inadequate attention, overconfidence, inexperience, inadequate unit training, and improper motivation. Inadequate attention was cited as the most frequent cause for the monitoring errors. Overconfidence was cited as the most frequent cause for the decision errors and inexperience for the improper control action errors.

Most Frequently Violated Procedures

Initially, the most frequently violated procedures were identified solely on the basis of frequency of occurrence. There were 15 frequently violated ATM procedures and 5 frequently violated non-ATM procedures identified involving rotary wing aircraft accidents (tables 3 and 4), four frequently violated ATM procedures, and seven frequently violated non-ATM procedures identified involving fixed wing aircraft accidents (tables 5 and 6). The 15 frequently violated ATM procedures involved in rotary wing aircraft accidents accounted for 43% of the rotary wing errors and the five non-ATM procedures accounted for 17% of the rotary wing errors. The four frequently violated ATM procedures involved in fixed wing aircraft accidents accounted for 48% of the fixed wing errors and the seven non-ATM procedures accounted for 22% of the fixed wing errors. Additionally, table 7 shows that these most frequently violated rotary wing and fixed wing procedures accounted for 72% (291) of the human error accidents during this time, 75% ($219,095,028) of the human error accident costs, 69% (102) of the fatalities, and 76% (293) of the injuries. Therefore, it is obvious that actions to eliminate violations of these procedures should assist in reducing accidental losses. The types of ATM and non-ATM procedures identified in the accident cases were consistent with the types of missions, flight environments, phases of flight, etc., that would be expected to be involved with Army aircraft operations.

Table 3 - FY84-89, Army Aviation Human Error Accidents (Class A-C) Most Frequently Violated Rotary Wing ATM Procedures

PROCEDURE	TASK/JOB/ACTIVITY	FREQUENCY
ATM 1035/2081	Terrain Flight	59
ATM 1017	Hovering Flight	33
ATM 1071	Perform as a Crewmember	23
ATM 1005	Preflight Inspection	20
ATM 1031	Confined Area Operations	20
ATM 1028	VMC Approach	18
ATM 1053	Simulated Engine Failure	18
ATM 1032	Slope Operations	13
ATM 2004	Pinnacle Operations	11
ATM 2084	Terrain Flight Approach	11
ATM 1015	Ground Taxi	10
ATM 1083	VHIRP	9
ATM 2016	External Load Operations	9
ATM 1001	Plan VFR Flight	8

Table 4 - FY84-89, Army Aviation Human Error Accidents (Class A-C) Most Frequently Violated Rotary Wing Non-ATM Procedures

PROCEDURE	TASK/JOB/ACTIVITY	FREQUENCY
AR 95-1	Perform PIC Duties	9
	Aerobatic Flight	6
	Cruise Flight	4
	Crew Selection/Scheduling	2
	Other Single Occurrences	5
TH55A FTG	Standard Autorotation	11
	Normal Approach	3
	Autorotation with Turn	2
	Anti-overspeed Control	2
	Sideward Hover	2
	Other Single Occurrences	4
TC 1-204	Mission Planning	9
	Crew Teamwork	5
	Formation Flt Separation	4
	Other Single Occurrences	2
TC 1-201	Crew Coordination	6
	Rappelling Operations	3
	Mission Planning	2
	Hazard Information	2
	Other Single Occurrences	6
OH-58 OM	Loss of Tail Rotor Effectiveness	8
	Loss of Tail Rotor Components	2
	Engine Malfunction	2
	Other Single Occurrences	2

Table 5 - FY84-89, Army Aviation Human Error Accidents (Class A-C)
Most Frequently Violated Fixed Wing ATM Procedures

PROCEDURE	TASK/JOB/ACTIVITY	FREQUENCY
ATM 1020	Normal Landing	10
ATM 1007	Taxiing	6
ATM 1027	Engine Failure Takeoff	3
ATM 1021	Power Approach/Precision Landing (PAPL)	3

Table 6 - FY84-89, Army Aviation Human Error Accidents (Class A-C)
Most Frequently Violated Fixed Wing Non-ATM Procedures

PROCEDURE	TASK/JOB/ACTIVITY	FREQUENCY
U21 Operators Manual	Check Propeller RPM	1
	Fuel Management	1
	Check Oil Filler Cap	1
C-7A Operators Manual	Manual Landing Gear Extension	1
	Check Landing Gear Position	1
AR 95-2	Airport Management	1
FM 1-240	Instrument Landing System (ILS) Approach	1
FM 1-203	Stall Recovery	1
RG8A Operator's Manual	Stall Characteristics	1
FAA Handbook	Traffic Separation	1

Table 7 - FY84-89, Army Aviation Human Error Accidents (Class A-C) Accidental Losses Accounted for by the Most Frequently Violated Procedures

PROCEDURE	ACCIDENTS	COST	FATALITIES	INJURIES
Rotary Wing:				
15 ATM Procedures	188	138,714,212	49	193
5 Non-ATM Procedures	80	72,672,840	44	89
Fixed Wing:				
4 ATM Procedures	14	1,938,602	1	6
7 Non-ATM Procedures	9	5,769,374	8	5
TOTAL	291	219,095,028	102	293

Prioritized Rankings

The most frequently violated procedures were then ranked internally using an average percentage value of four parameters. These parameters included frequency of occurrence, total accident cost, number of fatalities, and number of injuries. In addition, two rotary wing non-ATM procedures, the USAAVNC Flight Training Guide (FTG) for the TH-55A helicopter, and the loss of tail rotor effectiveness (LTE) procedures in the OH-58A/C operator's manual were deleted because they were no longer relevant to the Army aviation fleet. The TH-55 helicopter is no longer used in primary training, and the aircraft has been retired from the Army's inventory. Loss of tail rotor effectiveness in OH-58 aircraft was a transitory problem which has been corrected.

The internal ranking of the most frequently violated procedures that resulted are shown in table 8 for ATM procedures (rotary and fixed wing) and table 9 for non-ATM procedures (rotary and fixed wing). In those accident cases with more than one violated procedure, the total accident costs, fatalities, and injuries have been duplicated. Thus, for each procedure it would not be appropriate to calculate the percentage of the total for which each accounted.

Table 8 - FY84-89, Army Aviation Human Error Accidents (Class A-C) Prioritized Ranking of Violated ATM Procedures: Rotary Wing and Fixed Wing

Rotary Wing

ATM Task Number	Task/Job/Activity	Freq (%)	Cost* (%)	Fatal* (%)	Injury* (%)	AVG (%)
1035/2081	Terrain Flight	59 (22.52)	40.9M (29.53)	27 (51.92)	45 (20.55)	31.13
1071	Crew Coordination	23 (8.78)	11.4M (8.22)	4 (7.69)	34 (15.53)	10.05
1083	Vertical Helicopter Instrument Recovery Procedure (VHIRP)	9 (3.44)	15.5M (11.15)	10 (19.23)	7 (3.20)	9.25
1017	Hovering Flight	33 (12.60)	15.9M (11.49)	0 (0.00)	21 (9.59)	8.42
1001	Plan Visual Flight Rules (VFR) Flight	8 (3.05)	5.9M (4.30)	6 (11.54)	21 (9.59)	7.12
1028	Visual Meteorological Conditions (VMC) Approach	18 (6.87)	7.0M (5.07)	0 (0.00)	24 (10.96)	5.72
2004	Pinnacle Operations	11 (4.20)	5.6M (4.03)	3 (5.77)	15 (6.85)	5.21
1005	Preflight Inspection	20 (7.63)	13.5M (9.77)	1 (1.92)	1 (0.46)	4.95
1032	Slope Operations	13 (4.96)	2.9M (2.16)	0 (0.00)	27 (12.33)	4.86
1015	Ground Taxi	10 (3.82)	10.4M (7.50)	0 (0.00)	14 (6.39)	4.43
2016	External Load Operations	9 (3.44)	5.3M (3.85)	1 (1.92)	2 (0.91)	2.53
1053	Simulated Engine Failure	18 (6.87)	0.6M (0.46)	0 (0.00)	4 (1.83)	2.29
2084	Terrain Flight Approach	11 (4.20)	3.0M (2.16)	0 (0.00)	4 (1.83)	2.05
1031	Confined Area Operations	20 (7.63)	0.4M (0.30)	0 (0.00)	0 (0.00)	1.98
TOTAL		262	138.3M	52	219	

*Accident data duplicated for each procedure if more than one procedure violated in the accident.

Fixed Wing

ATM Task Number	Task/Job/Activity	Freq (%)	Cost* (%)	Fatal* (%)	Injury* (%)	AVG (%)
1027	Engine Failure Takeoff	3 (13.64)	1.5M (75.20)	1 (100.0)	6 (100.0)	72.21
1020	Normal Landing	10 (45.45)	0.3M (15.94)	0 (0.00)	0 (0.00)	15.35
1007	Taxiing	6 (27.27)	0.06M (3.43)	0 (0.00)	0 (0.00)	7.67
1021	Power Approach/Precision Landing (PAPL)	3 (13.64)	0.1M (5.44)	0 (0.00)	0 (0.00)	4.77
TOTAL		22	1.96M	1	6	

*Accident data duplicated for each procedure if more than one procedure violated in the accident.

Table 9 - FY84-89, Army Aviation Human Error Accidents (Class A-C) Prioritized Ranking of Violated Non-ATM Procedures: Rotary Wing and Fixed Wing

Rotary Wing

Reference	**Freq** (%)	**Cost*** (%)	**Fatal*** (%)	**Injury*** (%)	**AVG** (%)
AR 95-1	26 (39.39)	20.7M (28.63	16 (38.10)	40 (61.54)	41.91
TC 1-204	21 (31.82)	37.9M (52.52)	25 (59.52)	14 (21.54)	41.35
TC 1-201	19 (28.79)	13.6M (18.85)	1 (2.38)	11 (16.92)	16.74
TOTAL	66	72.2M	42	65	

*Accident data duplicated for each procedure if more than one procedure violated in the accident.

Fixed Wing

Reference	**Freq** (%)	**Cost*** (%)	**Fatal*** (%)	**Injury*** (%)	**AVG** (%)
C-7A Operator's Manual	2 (40.00)	0.7M (51.80)	0 (0.00)	4 (100.0)	63.93
U-21 Operator's Manual	3 (60.00)	0.6M (48.20)	0 (0.00)	0 (0.00)	36.07
TOTAL	5	1.3M	0	4	

*Accident data duplicated for each procedure of more than one procedure violated in the accident.

AR 95-1, Flight Regulations, contains general rules and policies for flying Army aircraft. TC 1-204, Night Flight Techniques and Procedures, contains specific procedures concerning night flying. TC 1-201, Tactical Flight Procedures, contains specific procedures regarding tactical flying in Army aviation. A complete listing of the most frequently violated ATM and non-ATM procedures including the specific tasks, jobs, and activities that were not complied with and more detailed cost data is contained in appendix D.

Top 15 Rotary Wing ATM Procedures

The top 15 most frequently violated rotary wing ATM procedures (table 8) accounted for 43.4% of the total human errors identified in the rotary wing accidents. The distribution of human performance errors and system inadequacies was generally consistent with the entire data base (402 usable cases). The major differences included: an absence of improvising errors, a larger percentage of misjudging errors, and slight variations in the order of system inadequacy frequency of occurrence. The table in appendix C, table 4 shows the distribution of the errors and their causes for the top 15 most frequently violated rotary wing ATM procedures.

The tables in appendix E, tables 1 and 2 show the distribution of rotary wing aircraft types and NVD used by ATM tasks. Almost half of the violations occurred in utility type aircraft (UH-1 and UH-60) while less than 10% occurred in cargo-type aircraft (CH-47 and CH-54). This is not surprising since the exposure is greater for the utility than the cargo-type aircraft. Approximately 10% (64) of the violations occurred at night, with 55% of these involving the use of NVD by person making error.

Indepth Analysis Packages

Analysis packages for each of the top 15 rotary wing, ATM-violated procedures were developed and are presented in appendices F (by procedure), G (by aircraft), and H (by NVD usage) in volume 2. The most often cited step/part of task 1035/2081, Terrain Flight, was obstacle avoidance. Monitoring errors accounted for 63% of these violations, and inadequate attention caused 76% of these monitoring errors. Communicating effectively and assigning crew duties were the two most often violated steps/parts of task 1071, Cockpit Teamwork, and, as expected, communication errors accounted for 65% of all violations of task 1071. For task 1083, VHIRP, initiating the climb and adjusting power for the climb were the two most often violated steps/parts. Improper control action was reported as the error in 44% of all violations of task 1083, and inadequate unit training was the most frequently reported cause overall.

Controlling lateral drift was the step/part violated the most for task 1017, Hovering Flight, with monitoring errors accounting for 33% of all violations of task 1017. Besides unknown or insufficient information which accounted for 26% of all causes, overconfidence and inadequate attention were the most frequently reported causes. As expected, complying with VFR requirements was the step/part violated the most for task 1001, Plan VFR Flight, with planning and decision errors comprising 100% of all violations of task 1001. For task 1028, VMC Approach, initiating go-arounds before descending below the obstacles and properly estimating rate of closure during approaches at night were the most often violated steps/parts. In similar fashion, monitoring errors accounted for 33% of all violations of task 1028 with inadequate attention causing 83% of the monitoring errors.

Ensuring out of ground effect (OGE) hover power was available during pinnacle operations, was the step/part of task 2004 most often violated. Overconfidence and inadequate unit training were sited in 64% of all error causes identified for task 2004. Removing covers, locking devices, and tiedowns and securing cowlings, doors, and panels were the two steps/parts violated most often for task 1005, Preflight Inspection. Not surprisingly, inspection errors accounted for 90% of all violations of task 1005. Unfortunately, 60% of all causes were listed as unknown or insufficient information. For task 1032, Slope Operations, the steps/parts violated most often were executing smooth, controlled ascents; applying lateral cyclic into the slope; and maintaining heading perpendicular to the slope. Improper control actions accounted for 46% of all errors on task 1032, and overconfidence and inexperience were cited in 73% of the total causes identified.

Clearing the aircraft from obstacles was the only step/part of task 1015, Ground Taxi, that was violated. Decision errors accounted for 60% of all of the violations of task 1015 (two of these were crew coordination failures), and overconfidence and inadequate motivation were the most reported causes overall (62%). There were no frequently cited steps/parts of task 2016, External Load Operations. (There were 8 steps/parts cited for nine errors.) Improper control actions accounted for 44% of all violations of task 2016, with improperly designed equipment cited in 25% of all causes. For task 1053, Simulated Engine Failure, the most frequently violated cited steps/parts were maintaining rotor RPM within limits, establishing normal operating RPM, adjusting cyclic to attain a landing attitude, and using collective to cushion the landing. There were no error trends. The most frequent errors for task 1053 were decision, monitoring, and inspecting errors. Sixty-three percent of the reported causes for violations of task 1053 were unknown or insufficient information.

During terrain flight approaches, task 2084, deciding how to terminate the maneuver (i.e., to a hover, to the ground, or run-on landing) and maintaining ground track alignment were the two most often violated steps/parts. There were no error or cause patterns noted. During task 1031, Confined Area Operations, evaluating obstacles was the step/part violated most often with monitoring errors (55%) and inadequate attention (42%) the most frequently cited error and cause for all task 1031 violations.

Systemic Source Analysis

In developing the indepth analysis packages requested by the USASC for the top 15 rotary-wing-violated procedures, two problem areas were dominant:

1. Monitoring errors caused primarily by inadequate attention which were further pinpointed as scanning errors,

2. Planning, decision, and communication errors which were further pinpointed as crew coordination failures.

Together, these two problem areas accounted for 46% of the total number of errors involved in the top 15 rotary wing procedures. Inadequate attention was cited as the cause for almost 71% of the monitoring errors within the top 15 violated procedures versus 59% for all 402 cases. A detailed analysis of these two primary problem areas uncovered three different types of scanning errors and five of six crew coordination failures previously defined by the USASC.

The scanning errors were categorized as either fixated, limited, or improper technique. Fixated scans describe a crewmember who discontinues head and eye movement when searching his field of view. Limited scans describe a crewmember who searches only a portion of his field of view. Improper techniques describe a crewmember who scans too close in, too far out, too fast, or too slow. Tables 10-12 show the scanning errors distributed across the top 15 rotary wing ATM tasks, rotary wing aircraft types, and period of day (including NVD usage). As might be expected, these errors occurred during flight close to obstacles (72% of scanning errors happened during terrain flight, hovering flight, or confined area operations), involved a variety of helicopter types (85% of scanning errors involved the AH-1, UH-1, OH-58 and UH-60), and occurred predominantly during the day (82%).

Table 10 - Scanning Errors by the Top 15 Rotary Wing ATM Tasks

Aircrew Training Manual Tasks

Error Type	1035 2081	1017	1031	1028	1053	1071	1015	1083	2084	1032	2016	Total
Fixated	15	7	2	3	1	2	1	2				33
Limited	14	3	7	3		1	2	1				31
Technique	8	1	2		3				2	1	1	18
Totals	37	11	11	6	4	3	3	3	2	1	1	82

Table 11 - Scanning Errors by Rotary Wing Aircraft Type

Aircraft Type

Error Type	AH1	UH1	OH58	UH60	AH64	MH6	CH47	OH6	Total
Fixated	8	6	9	6	2	2			33
Limited	9	9	5	6			1	1	31
Technique	3	5	2	2	2	2	1	1	18
Totals	20	20	16	14	4	4	2	2	82

Table 12 - Scanning Errors by Period of Day and Type of NVD

Period of Day/Type of NVD

Error Type	Total	Day	Night	ANPVS-5	ANVIS-6	FLIR	PNVS	Unaided
Fixated	33	23	10	1	1	1	1	6
Limited	31	26	5	3	2			
Technique	18	18						
Totals	82	67	15	4	3	1	1	6

The crew coordination failures were grouped analytically according to the USASC categories which include: failures to direct assistance, announce decisions, use positive communications, assign crew duties, offer assistance, and sequence actions. There were no reported instances of sequencing action failures within this data. Tables 13-15 show the crew coordination failures distributed across the top 15 rotary wing ATM tasks, rotary wing aircraft types, and period of day (including NVD usage). The most frequently cited failure (53% of the crew coordination failures) involved non-flying crewmembers failing to provide needed assistance or information to the flying crewmember. Half of the crew coordination failures occurred in utility helicopters (UH-1 and UH-60) while cargo helicopters (CH-47 and CH-54) accounted for only 8%. Like the scanning errors, almost 74% of the crew coordination failures occurred during the day.

Table 13 - Aircrew Coordination Failures by Top 15 Rotary Wing ATM Tasks

Aircrew Training Manual Task

Failure Types	1071	1035/ 2081	1015	1028	2004	2016	1017	1001	Total
Direct Assistance	3		1						4
Announce Decision	2			1			1		4
Positive Communication	4	1							5
Assign Crew Duties	2		1		1			1	5
Offer Assistance/Information	12	7				1			20
Totals	23	8	2	1	1	1	1	1	38

Table 14 - Aircrew Coordination Failures by Rotary Wing Aircraft Type

Aircraft Type

Failure Types	UH-1	UH-60	OH-58	AH-1	CH-47	CH-54	OH-6	MH-6	Total
Direct Assistance	1		2		1				4
Announce Decsision	2	1		1					4
Positive Communication	1	3	1						5
Assign Crew Duties	4				1				5
Offer Assistance/Information	4	3	5	5		1	1	1	20
Totals	12	7	8	6	2	1	1	1	38

Table 15 - Crew Coordination Failures by Period of Day/Type of NVD

Period of Day/Type of NVD

Failure Types	Total	Day	Night	ANVIS-6	ANVPS-5	Unaided
Direct Assistance	4	2	2	1	1	
Announce Decision	4	2	2		1	1
Positive Communication	5	3	2	2		
Assign Crew Duties	5	5				
Offer Assistance/Information	20	16	4	2	1	1
Totals	38	28	10	5	3	2

Publication Review

The various ATM and non-ATM publications and their supporting references were reviewed to determine the adequacy with which the violated procedures are written and presented in hard copy. That is, they were reviewed to determine how well the publications presented critical information about the specific tasks, jobs, or activities identified during this study. This review also included all the ATM training circulars (TC 1-209 through 1-218), the publications cited in tables 4 and 6 of this report, and the supporting references for each of these publications.

As a general rule, the publications appeared to provide sufficient information about the specific step or part of the procedure that was violated. As an example, all the training circulars and their supporting references dealing with the most frequently violated ATM task, 1035/2081, Perform Terrain Flight, provide guidance concerning obstacle avoidance and obstacle clearance. It was found that the emphasis on "obstacle avoidance or obstacle clearance" was reiterated an average of seven times throughout the standards, description, and night or NVG parts of the task. Two of the six supporting references listed at the end of the terrain flight task in each training circular also provide users with comprehensive and pertinent "how to" information relating to scanning techniques and visual illusions to assist aviators in seeing and avoiding obstacles.

For ATM task 1017, Hovering Flight, the requirement to maintain lateral drift is referred to an average of five times throughout the standards and Night Vision Goggle (NVG) parts of the task. Likewise, the requirement to immediately establish and maintain a climb is clear and distinct in all the training circulars pertaining to ATM task 1083, Vertical Helicopter Instrument Recovery Procedures.

In contrast, the training circulars and their supporting references dealing with ATM task 1071, Cockpit Teamwork, do not adequately address two of the crew coordination failure categories identified by the USASC and found within the crew coordination failures identified by this study. Specifically, the requirement to offer assistance or information to the flying crewmember and the need to announce decisions are not discussed in the ATM task or in any of the supporting references. They do, however, emphasize the requirement for positive communications using standard terminology.

Summarily, the quality of training publications was not found to be a major contributing factor affecting the outcome of the accident cases reviewed. This deduction is further substantiated by the relatively low frequencies of occurrence shown for the systemic cause category, "inadequate written procedures," on the tables contained in appendices C1-C4.

Institutional Training

A review of the FTGs used for the Instructor Pilot Methods of Instruction (IP/MOI) Course for a variety of aircraft types at the USAAVNC revealed that procedures for instructing the trainers about crew coordination requirements and scanning techniques were poor. Although the individual FTG tasks contained similar information about scanning requirements as the ATMs, discussions with instructor pilots in the Initial Entry Rotary Wing (IERW) Course revealed a lack of standardized procedures for teaching new aviators how to properly scan their sectors of responsibility during aided and unaided flight. Furthermore, the instruction is oriented toward the individual aviator, not cockpit crewmembers.

The USAAVNC has instituted changes to its written procedures and is planning to change training methods relating to crew coordination and proper scanning techniques. Within the past year, a new appendix for TC 1-204, Night Flight Techniques, dealing with crew coordination and scanning during NVG operations in the desert has been distributed to the field. In addition, the revised TC 1-210, ATM Commander's Guide and TC 1-214, ATM Attack Helicopter, AH64, both have incorporated crew coordination requirements into the training plan and individual ATM tasks. These same requirements are to be incorporated into all future revisions of the ATM's.

Additionally, the Commandant of the USAAVNC has directed that crew coordination be integrated into the IERW and other training courses. The extent to which that has been accomplished could not be accurately determined during the timeframe of this study. Although informal discussions with contractor personnel responsible for this training indicated that efforts were ongoing to place increased emphasis on crew coordination requirements consistent with the maneuver being taught, this integration will probably not be accomplished in a standardized manner until all the ATMs and FTGs have been revised.

CONCLUSIONS

Improper monitoring and crew coordination failures accounted for 46% of the total errors identified in the top 15 rotary wing ATM-violated procedures. A large percentage (71%) of the monitoring errors (mostly scanning errors) was caused by inadequate attention. The specific types of scanning errors committed were evenly divided between limited and fixated with improper technique being cited the least number of times. This distribution of scanning errors is consistent with the types of flight tasks being performed. Two exceptions to this distribution were hovering flight where fixated scans were the dominant problem and confined area approaches where limited scans were the biggest problem. Scanning errors did not appear to be a major problem for any particular type of aircraft or NVD if the differences in exposure for each type aircraft are considered.

The ATM tasks associated with flight close to the earth's surface adequately address the requirement to remain clear of obstacles, and the supporting references provide sufficient guidance about scanning and obstacle avoidance techniques. However, the methods of imparting this information during institutional training and the degree of emphasis placed on the technique and teamwork required to optimize crewmember scanning effectiveness do not appear to be standardized or effective. The leading type of crew coordination failure was the failure of crewmembers not on the controls to offer assistance or information that was needed or had been previously requested by the crewmember on the controls. This and other types of crew coordination failures occurred more often in utility helicopters than in other types, while cargo helicopters had a much lower incidence.

Accordingly, there may be valuable lessons to be learned from cargo helicopter procedures that can be applied to other types of helicopters. Although almost all of the ATM's address crew coordination as a specific task (task 1071), detailed implementing guidance was not developed and integrated into those tasks wherein crew coordination is a critical element.

Both of these problem areas have been previoulsy identified by the USAAVNC and are being addressed through publication revisions and training program modifications. The in-depth analysis packages contained in Volume 2 of this study provide detailed information pertaining to the specific step or part of each violated procedure and the causes of the violations which should prove useful during the revision of the ATM's and their supporting references. Knowing the specific part of a task that is frequently violated and the reason why it was violated will facilitate the revision process. This information will also benefit training developers, institutional and unit trainers, and evaluators in the formulation and execution of training programs.

Surprisingly, more that 24% of the systemic causes reported for the identified errors in the entire analysis were attributed to the category "unknown or insufficient information." Within the top 15 rotary wing ATM violated procedures, the unknown or insufficient information category was mostly cited in less severe accidents (Class C). As most of these investigations were conducted by personnel from sources other than USASC Centralized Accident Investigation (CAI) boards, this high percentage of unknown cause factors may reflect an inadequate level of training provided to aviation personnel who are responsible for investigating accidents or investigative inexperience on the part of field unit investigators. As a result, a major segment of information that could influence the usefulness of this and similar studies, based on the same accident data, was not available.

A large percentage (59%) of monitoring errors were reported to be caused by inadequate attention. This percentage was even higher (71%) for the monitoring errors involved in the top 15 rotary wing, ATM-violated procedures. This systemic cause category does little to explain the nature of a monitoring error. It does not provide any information as to where the aviator's attention was focused and why it was focused there. For untrained accident investigators, it provides an easy, but uninformative and inconclusive choice without actually having to investigate the true cause of the monitoring error.

There was a large number of decision errors in the entire data sample (N = 145). These errors included a variety of judgmental errors associated with assessing relative risk. Although time was not available during this study, these decision errors should be examined in greater detail to determine commonality of error types, trends with respect to different types of risk, and recurring causes.

RECOMMENDATIONS

The results of this research were used to develop the following recommendations:

- The USASC should provide the in-depth analysis data contained in volume 2 of this study to the various elements of the USAAVNC listed below to support specific Night Aviation Council of Colonels actions.

  - To ATB to validate the proposed scanning procedures developed by the U.S. Army Aeromedical Research Laboratory.

  - To ATB and DOTD for use during Program of Instruction (POI) modification to incorporate crew coordination and scanning techniques into the IERW and other courses.

  - To DOTS for use during the revision process for the aircrew training manuals.

  - To DES for use during training program evaluations of Army aviation units.

- The USASC should reduce the number of unexplained errors and improve the overall quality of accident reports by:

  - Deleting the systemic cause category of inadequate attention (code SI05) from the 3W taxonomy of causes. This action will require all monitoring errors to be investigated to a greater depth in order to determine why an aviator's attention was not concentrated at the proper place at the proper time.

  - Major Command (MACOM) and subordinate unit commanders should designate aviators at each installation or location with concentrations of aviation assets to perform accident investigation duties on a more routine basis and provide investigation training to these aviators.

- The USASC should consider further research in this area to examine, in detail, frequently committed decision errors to determine commonality of error types, trends with respect to assessing different types of risk, and recurring causes of these judgmental errors.

APPENDIX A

DEFINITIONS OF TASK ERRORS (HUMAN ERRORS) AND SYSTEM INADEQUACIES

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DEFINITIONS, EXAMPLES, AND KEY WORDS FOR TASK ERRORS (TE) AND SYSTEM INADEQUACIES

TASK ERRORS

GENERAL. These definitions and examples are provided so all users will have the same understanding of what the factors mean. Also, a list of key words is given for each factor. A key word can be used in place of the factor name to give users more flexibility in describing the cause of an accident.

TASK ERRORS: Mistakes made by Government personnel that contribute to accidents.

TE-01. Inadequate inspection/check. Failure to properly look, listen, or feel in different locations for something, not knowing if, where, or when it may occur.

Examples: Perform preflight equipment checks.
Inspect equipment or vehicle to decide its operational readiness.
Read forms, notices, Standard Operating Procedures (SOPs), Training Manuals (TMs), ARs, etc., to get needed information.

Key Words: locate, read, detect, observe

TE-02. Improper monitoring. Failure to monitor one or more activities or operations.

Examples: Search field of view for hazards, e.g., look in both directions at an intersection, look where walking.
Watch performance of personnel to guard against mistakes.
Scan instruments for signs of proper vehicle or equipment functioning.
Instructor watching performance of both student and vehicle.
Exercise quality control over maintenance.

Key Words: divide attention, monitor, scan, survey, time share, word search

TE-03. Failed to recognize. Failure to determine what something is and what its characteristics are so it can be distinguished from other things that are similar.

Examples: Identify a control by feeling its shape.
Recognize status of an on-off switch by feeling its position.
Recognize changes in engine or machine sounds as a possible malfunction.

Key Words: identify, discriminate, distinguish

TE-04. Misjudged clearance/speed/weight/size/distance/time. Improper evaluation of size, weight, temperature, movement,direction, distance, time or sound of things seen, heard, or felt without the use of measurement devices.

Examples: Estimate clearance between vehicle and other objects: e.g., a building or another vehicle, trees, etc., Judge rate of closure between vehicle and other objects; e.g., curve in road or in the case of an aircraft, rate of closure toward ground during autorotation.

Key Words: compare, estimate, evaluate

TE-05. Misinterpreted. Failure to properly apply logic, rules, or computational steps to information so it can be correctly interpreted and used in performing the task at hand.

Examples: Compute vehicle or equipment fuel consumption.
Compute aircraft weight and balance.
Interpret clues to find the source of an engine malfunction.
Interpret written instructions or oral communications.

Key Words: calculate, categorize, code, compute, itemize, process, tabulate, translate

TE-06. Failed to anticipate. Failure to expect immediately upcoming events (short-term planning, to be prepared to act or react accordingly).

Examples: Keep ahead of vehicle; e.g., be prepared for common emergencies such as skids, tire blowouts, brake failures, and engine power losses.
Anticipate another person's actions; e.g., defensive driving, instructor anticipating a student's action or reaction.

Key Words: expect, foresee, prepare for

TE-07. Inadequate planning. Failure to properly organize actions and plan for future job needs.

Examples: Schedule work.
Plan mission.
Assign personnel to duties; e.g., vehicle driver/aircraft crew selection.
Allocate equipment, vehicles, and other resources for job or mission.

Key Words: allocate, assign, coordinate, direct, organize,schedule

TE-08. Improper decision. Selection of an improper course of action when:

a. The best choice could be made using available information.
b. The best choice could be carried out using available resources.
c. One rule, principle, or procedure for deciding the course of action clearly applied.

Examples: Make "go no-go" decision based on weather conditions, crew qualifications, and vehicle capabilities.
Decide whether to use personal protective equipment considering hazards of existing conditions.

Key Words: choose, determine, analyze, elect, select

TE-09. Inadequate improvising/troubleshooting/problem solving. Failure to devise a workable course of action when:

a. The best course of action could not be decided using available information.
b. The best course of action could not be carried out using available resources.
c. One rule, principle, or procedure for deciding the course of action did not clearly apply.

Examples: Change aircraft flight route according to weather, visibility, or other environmental conditions.
Make a field-fix replacement for a broken part.
Devise a way of communicating after communications equipment failed.

Key Words: adapt, devise, fabricate, invent

TE-10. Improper control action. Improper performance of separate, simple movements made with a certain purpose in mind; e.g., completing job, task, or part of a task. A task may demand that such movements be made once, repetitively, or in sequence and require the person to estimate when to start, how much force to use, how long and how many times to apply the force, and when to stop.

Examples: Activate a toggle switch or start/stop button, shift vehicle transmission lever, or lift objects (positioning actions).
Type, operate calculator, or carry out a sequence of actions to start a vehicle (serial actions).

Key Words: lift, hold, drop, hit, push, pull, sit, stand, reach for, open, close, connect, disconnect, activate, press, turn, grasp, grip, set, start

Improper performance of action(s) involving coordinated movements to which continuous adjustments are made based on information related to the task at hand. A task involving such movements may require the person to estimate when to start, how much force to apply, how long to continue, and when to stop.

Examples: Antitorque pedals.
Apply aircraft collective control.
Track target with a gun.
Coordinate aircraft flight controls.

Key Words: walk, run, crawl, climb, carry, jump, align, adjust, steer, brake, aim, accelerate, swim, throw, track

TE-11. Inadequate communication. Failure to convey facts, instructions, or directives required to perform a task by speaking, writing, signaling, or otherwise giving information to be acted upon.

Examples:	Vehicle commander conducts pre-mission briefing for crew. Unit commander gives personnel information (ARs, TMs, FMs, SOPs, etc.) required for job performance. Ground guide signals instructions to vehicle operator.
Key Words:	ask, answer, signal, inform, advise, direct, indicate, instruct, request, speak, transmit, write

SYSTEM INADEQUACIES

These definitions and examples are given so all users will have the same understanding of what the system inadequacies mean.

SI-01. Inadequate school training. School training becomes a system inadequacy when people make accident-causing errors because the school training provided was inadequate in content or amount.

Examples: UH-1M IP improperly monitored the performance of a rated student pilot (RSP) (failed to "guard" the collective) because of inadequate school training. IP school training does not teach IPs how to properly monitor the control inputs of a student.

SI-02. Inadequate unit training. Unit training becomes a system inadequacy when people make accident-causing errors because the unit training provided was inadequate in content or amount.

Examples: UH-1H PIC of lead aircraft (acting as copilot and formation commander) inadequately planned spacing and command and control procedures for the formation flight because of inadequate unit training. That is, his unit did not have a training program to establish and maintain proficiency in formation flying techniques for those aviators who were not receiving formation training from their unit in accordance with AR 95-1, FM 1-51, and TC 1-135. As a result, the formation commander (PIC lead, UH-1H) was not familiar with correct spacing in formation or command and control procedures for formation flying.

SI-03. Inadequate experience. Supervised on-the-job experience is the follow-on to school and unit training programs. Experience becomes a system inadequacy when people make accident-causing errors because the experience provided was inadequate in content or amount.

Examples: IP inaccurately estimated clearance/closure (failed to maintain tail rotor clear of ground) because of inadequate experience. As one of three unit UH-1 IPs responsible for training needs of only 10 UH-1 aviators, he was tasked too infrequently to maintain a high level of proficiency in conducting nap of the earth (NOE) training: e.g., he had not demonstrated a quick stop/deceleration for a period of 3 months prior to the date of the accident.

SI-04. Inadequate composure. Each person is a part of the system. Therefore, his/her state of mind is a system element. Inadequate composure is a temporary state of mind that becomes a system inadequacy when a person makes an accident-causing error because fear, excitement, or some related emotional factor made clear, rational thought impossible.

Examples: Flight engineer misinterpreted an in-flight failure (wrongly interpreted failure of forward transmission oil cooler fan as impending power train failure) because of inadequate composure. That is, he had experienced two previous combining transmission failures and was admittedly afraid of the possible consequences.

SI-05. Inadequate attention. Inadequate attention is a temporary state of mind that becomes a system inadequacy when a person makes an accident-causing error because his or her attention was not properly focused on the task at hand.

Examples: UH-1H IP inadequately searched his field of view to keep aware of the aircraft attitude during the low-level deceleration because of inadequate attention. That is, he elected to check the aircraft instruments and look at the pilot's face for "any unusual signs of stress" instead of looking outside the cockpit. As a consequence, he did not detect the excessive attitude in sufficient time to initiate corrective action.

SI-06. Overconfidence. Overconfidence is a temporary state of mind that becomes a system inadequacy when an accident is caused by a person's unwarranted reliance on:

a. His or her own ability to perform a task.
b. The ability of someone else to perform a task.
c. The performance capabilities of equipment or other material.

Examples: Pilot made an improper decision (hovered over snow-covered terrain in a manner conducive to causing recirculating snow) because of overconfidence. The pilot had been routinely flying in recirculating snow conditions for 3 days up to the time of the accident without difficulty and believed that he was fully capable of coping with the existing environment. As a result, he had not developed a full appreciation for the probability of inadvertently encountering a loss of outside visual references and was admittedly caught by surprise when it occurred.

SI-07. Lack of confidence. Lack of confidence is a temporary state of mind that becomes a system inadequacy when an accident is caused by a person's unwarranted lack of reliance on:

a. His own ability to perform a task.
b. The ability of someone else to perform a task.
c. The performance capabilities of equipment or other material.

Examples: Pilot made an improper decision (did not switch fuel selectors from main tanks to auxiliary tanks after 1 hour of flight) because of a lack of confidence in the aircraft's fuel quantity gauges. Pilot admittedly lacked confidence in the reliability of the U-8 fuel quantity gauges in general and stated that he did not refer to them during the flight. Accordingly, although the gauges in the aircraft were not written up as defective, he deliberately omitted this means of visually monitoring fuel quantity and was unaware that main tanks were becoming exhausted of fuel.

SI-08. Inadequate motivation/mood. Inadequate motivation/mood is a temporary state of mind that becomes a system inadequacy when a person makes an accident-causing error because his or her motivation/mood had a negative influence on performance of the task.

Examples: UH-1H pilot made an improper decision to take off without refueling because of inadequate motivation/mood (haste). That is, he was on his way to his home base after a 3-week training exercise and allowed a feeling of "get-homeitis" to override the prudence of filling the fuel tanks before departing on the last leg of the flight.

SI-09. Fatigue. Fatigue is a temporary physical and/or mental state that becomes a system inadequacy when a person makes an accident-causing error because of reduced physical or mental capabilities resulting from previous activity and/or lack of rest.

Examples: Pilot made an improper decision (hovered over snow-covered terrain in manner conducive to causing recirculating snow) because of fatigue. At time of accident, he had exceeded day/night flight and total duty limits of AR 95-5, table 5-1, and admittedly was momentarily confused as to what he should do when the aircraft became engulfed in rotor-induced recirculating snow and he lost outside visual references. By the time he made the decision to add power and climb above the recirculating snow, the left skid had already dug into the snow-covered terrain while the aircraft was slipping to the left, and the subsequent rollover to the left became inevitable.

SI-10. Effects of alcohol, drugs, or illness. The temporary effects of alcohol, drugs, or illness become system inadequacies when a person makes an accident-causing error because of reduced physical or mental capabilities resulting from one or more of these effects.

Examples: The general mechanic failed to follow procedures (misappropriated a UH-1 helicopter and attempted to fly it) because of the effects of alcohol and drugs. That is, the results of his autopsy lab tests revealed a blood-alcohol level of 0.17 and traces of marijuana.

SI-11. Habit interference. Habit interference becomes a system inadequacy when a person makes an accident-causing error because task performance was interfered with by:

a. The way he or she usually performs similar tasks.
b. The way he or she usually performs the same task under different conditions or with different equipment.

Examples: Pilot made an improper simple physical action (reduced the thrust lever to the detent position during running landing) because of habit interference.

That is, he expected to attain the proper pitch attitude at that position. However, because of significant differences of the detent position between this aircraft (YCH-47D) and other CH-47 aircraft (pilot had 1,000 hours in CH-47A, B, C series) he could not achieve the proper pitch attitude.

SI-12. Environmental conditions. Environmental conditions become system inadequacies when they affect personnel or materiel and cause an accident.

Examples: OV-1D engine compressor blades bent because of environmental conditions foreign object damage (FOD) as verified by teardown analysis. The source of the FOD is unknown but is suspected to be ice. The aircraft had been in moderate icing conditions and was in the process of descending to a lower altitude when the suspected ice ingestion occurred.

SI-13. Inadequate facilities or services. Inadequate facilities or services become system inadequacies when the space and support provided for personnel and materiel to accomplish their functions cause errors or failures/malfunctions that lead to accidents. (Examples of facilities and services are recreation areas, petroleum, oil, lubricants (POL) services, housing, medical clinics/hospitals, weather services, storage areas, maintenance facilities, and property disposal.)

Examples: UH-1H pilot made an improper decision (parking aircraft with inadequate rotor clearance) because of inadequate facilities. The refueling system was laid out with 50 feet separation between points 3 and 4. FM 10-68, para 7-15, recommends 100 feet separation, but the minimum is 75 feet between temporary and semipermanent AH-1 and UH-1 refueling points. The FARE system layout also recommends 100 feet separation with 80 feet being the minimum (FM 10-68, para 7-4 and 7-6).

SI-14. Equipment/materiel improperly designed/not provided. Equipment/materiel that is improperly designed or not provided becomes a system inadequacy when it leads to accident-causing personnel errors or materiel failures/malfunctions.

Examples: OH-58 fuel governor main control spring vibrated to a point of malfunction because of inadequate design for required operating conditions. The main control spring in the governor was changed to an alternate vendor supplied item to replace the original spring. This new spring will enter a resonance state if subjected to a 980 Hz vibration and detune itself, causing a loss of tension and a resulting restriction of fuel flow. When the tail rotor on this aircraft set up a vibration at 980 Hz, the vibration was transmitted through the airframe via the engine mount to the fuel control/governor and the main control spring, causing it to detune and restrict the fuel flow. All this resulted in a partial power loss and hard landing.

SI-15. Inadequate manufacture, assembly, packaging, or quality control. The inadequate manufacture, assembly, packaging, or quality control of materiel becomes a system when it leads to accident-causing personnel errors or materiel failures/malfunctions.

Note. Includes original manufacture and rebuild.

Examples: The OH-58A power turbine governor malfunctioned due to fretting during final approach because of inadequate quality control. That is, improper grease was used during overhaul. The bearing assembly was packed with MIL-G-81322 instead of manufacturer's recommended Unitemp 500 grease. This resulted in failure of the ball bearings (part number (PN) 2523237 and PN 2520501) due to ineffective lubrication and the resultant fretting mechanisms of the balls and ball paths on the inner and outer raceways.

SI-16. Inadequate maintenance. Inadequate maintenance (inspection, installation, troubleshooting, recordkeeping, etc.) becomes a system inadequacy when it leads to accident-causing personnel errors or materiel failures/malfunctions.

Examples: AH-1S (Mod) engine failed in flight (turbine section overheated) because of inadequate maintenance. That is, the fuel control was replaced on the engine but was mismatched with a temperature-sensing assembly from a fuel control to which it was not calibrated, contrary to instructions contained in TM 55-2840-229-24, Change 15, para 5-70.

SI-17. (Deleted)

SI-18. Inadequate written procedures for operation under normal conditions. Inadequate written procedures (ARs, TMs, FMs, SOPs, written directives) for normal conditions become system inadequacies when they lead to accident-causing personnel errors or materiel failures/malfunctions.

Examples: UH-1 tail rotor pitch change travel became obstructed (limited) in flight because of inadequate written procedures. The instructions in TM 55-1520-210-23-2, para 11-110b, are incorrect in that they call for extending the pitch change links for excessive right pedal in cruise flight when, in fact, the pitch change links should be shortened. As a result, the excessive right pedal condition was worsened when the prescribed procedures were followed by maintenance to correct the problem.

SI-19. Inadequate written procedures for operation under abnormal or emergency conditions. Inadequate written procedures (AR, TM, FM, SOP, written directives) for emergency conditions become system inadequacies when they lead to accident-causing personnel errors or materiel failures/malfunctions.

Examples: Pilot misinterpreted powerplant malfunction (interpreted total failure as partial power) because of inadequate written procedures for operation under emergency conditions. TM 55-1520-228-10, para 9-7 and 9-19, does not adequately explain the difference between partial power failures and engine underspeeds, nor does it define the limits of an engine underspeed.

SI-20. Inadequate supervision or coordination by higher command; unit command (SI-21); staff officer (SI-22); or direct supervisor (SI-23). Inadequate supervision becomes a system inadequacy when it leads to accident-causing personnel errors or materiel failures/ malfunctions.

Examples: Pilot performed an improper control action (did not coordinate collective pitch and cyclic so as to keep the tail rotor clear of obstacles during an NOE quick-stop maneuver) because of inadequate supervision by the IP. The IP had experienced improper control action by the pilot on two previous quick-stops at a higher altitude. He then placed the pilot at a 5-foot hover skid height downwind with the center of gravity (CG) aft (142.78) for another NOE quick-stop without restricting the pilot's cyclic control latitude.

APPENDIX B

DATA RECORDING FORM

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MOST FREQUENTLY VIOLATED AVIATION PROCEDURES/INDICATORS OF INDISCIPLINE -- CASE REVIEW SHEET

Case # ____________ Reviewer ____________

Identify the procedure governing correct performance that was not complied with and the duty position of the individual committing the error. Relate the appropriate task error and system inadequacy(s) to that reference. Indicate the phase of flight when the error occurred. Where appropriate, indicate the type of high risk behavior, whether the error was a flagrant violation or not, the activity, job, or task being performed when the error occurred, and additional reference.

Reference ________ Duty Position ______ TE______ SI ____ Behavior Type ____ F/N ____
Chapter ______ ATM Task # ______ SI ____ Behavior Type ____ F/N ____
Para ______ Note # ______ TD# ______ P/F ______ SI ____ Behavior Type ____ F/N ____
Page ______ Standard # ______ TC ______ SI ____ Behavior Type ____ F/N ____
Task/Job/Activity being performed ____________ SI ____ Behavior Type ____ F/N ____
Additional Reference ____________

Reference ________ Duty Position ______ TE______ SI ____ Behavior Type ____ F/N ____
Chapter ______ ATM Task # ______ SI ____ Behavior Type ____ F/N ____
Para ______ Note # ______ TD# ______ P/F ______ SI ____ Behavior Type ____ F/N ____
Page ______ Standard # ______ TC ______ SI ____ Behavior Type ____ F/N ____
Task/Job/Activity being performed ____________ SI ____ Behavior Type ____ F/N ____
Additional Reference ____________

Reference ________ Duty Position ______ TE______ SI ____ Behavior Type ____ F/N ____
Chapter ______ ATM Task # ______ SI ____ Behavior Type ____ F/N ____
Para ______ Note # ______ TD# ______ P/F ______ SI ____ Behavior Type ____ F/N ____
Page ______ Standard # ______ TC ______ SI ____ Behavior Type ____ F/N ____
Task/Job/Activity being performed ____________ SI ____ Behavior Type ____ F/N ____
Additional Reference ____________

Reference ________ Duty Position ______ TE______ SI ____ Behavior Type ____ F/N ____
Chapter ______ ATM Task # ______ SI ____ Behavior Type ____ F/N ____
Para ______ Note # ______ TD# ______ P/F ______ SI ____ Behavior Type ____ F/N ____
Page ______ Standard # ______ TC ______ SI ____ Behavior Type ____ F/N ____
Task/Job/Activity being performed ____________ SI ____ Behavior Type ____ F/N ____
Additional Reference ____________

APPENDIX C

DISTRIBUTION OF ERRORS AND CAUSES

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TABLE 1 FY84-89, ARMY AVIATION HUMAN ERROR ACCIDENTS (CLASS A-C)
TASK ERRORS CONTAINING VERIFIABLE HUMAN ERROR BY SYSTEM INADEQUACIES
IN THE 402 ACCIDENT CASES ANALYZED

		System Inadequacies*																				
Task Errors	N	05	06	03	02	08	18	23	04	14	09	07	11	19	21	12	01	22	13	16	97	**Total**
Monitor (02)	181	107	21	15	9	2	6	1	2	5	5	2		1	2				1		42	221
Decide (08)	145	3	46	12	17	31	7	5	2	2	3	8	1	1	3		2				39	182
Control (10)	95	13	2	37	13		5	8	11	3	1		5	2		1	1				22	124
Inspect (01)	48	8	3		1	3	3	1		1			1							1	28	50
Communicate (11)	45	2	9	3	9		1	2	1				1	1				1			19	49
Misjudge (04)	37	3	9	10	4	2	1		1	3				1		3	1	2	1		7	48
Plan (07)	30		10	3	3	4	1						1					1			9	32
Recognize (03)	26	5	2	1	2	1	2			4			1			1					11	30
Anticipate (06)	24	1	10	4	5		1	1	1		1				2						4	30
Misinterpret (05)	13			3	3		3	1			1			1							5	17
Improvise (09)	06						1														5	6
Total	650	142	112	88	66	43	31	19	18	18	11	10	10	7	7	5	4	4	2	1	191	789

System Inadequacy Definitions

01 Inadequate School Training
02 Inadequate Unit Training
03 Inadequate Experience
04 Inadequate Composure
05 Inadequate Attention
06 Overconfidence
07 Underconfidence
08 Inadequate Motivation
09 Fatigue
11 Habit Interference
12 Environmental Conditions
13 Inadequate Facilities/Services
14 Inadequate Design
16 Inadequate Maintenance
18 Inadequate Procedures - Normal
19 Inadequate Procedures - Emergency
21 Inadequate Supervision - Unit
22 Inadequate Supervision -Staff
23 Inadequate Supervision - Direct
97 Insufficient Information

*An error may be caused by more than one system inadequacy

TABLE 2 FY84-89, ARMY AVIATION HUMAN ERROR ACCIDENTS (CLASS A-C) TASK ERRORS CONTAINING VERIFIABLE HUMAN ERROR BY SYSTEM INADEQUACIES IN THE 369 ROTARY WING ACCIDENT CASES ANALYZED

		System Inadequacies*																			
Task Errors	N	05	06	03	02	08	18	23	04	14	09	07	11	21	19	12	22	01	13	16	97	**Total**
Monitor (02)	167	101	18	15	8	2	5	1	2	5	5	2		2	1				1		36	204
Decide (08)	139	3	44	11	15	31	7	5	2	2	3	6	1	3				2			39	174
Control (10)	90	13	2	34	11		5	8	11	3	1		4		2	1					21	116
Communicate (11)	42	1	8	3	9		1	2	1				1		1		1				18	46
Inspect (01)	39	4	2		1	3	3	1		1			1							1	24	41
Misjudge (04)	35	3	9	8	4	2	1		1	3					1	3	2	1	1		7	46
Plan (07)	29		10	3	3	4	1										1				9	31
Recognize (03)	23	5	2	1	2		2			3			1			1					9	26
Anticipate (06)	23	1	10	4	5		1				1			2							4	28
Misinterpret (05)	12			2	3		2	1			1				1						5	15
Improvise (09)	5						1														4	5
Total	604	131	105	81	61	42	29	18	17	17	11	8	8	7	6	5	4	3	2	1	176	732

System Inadequacy Definitions

01 Inadequate School Training	12 Environmental Conditions
02 Inadequate Unit Training	13 Inadequate Facilities/Services
03 Inadequate Experience	14 Inadequate Design
04 Inadequate Composure	16 Inadequate Maintenance
05 Inadequate Attention	18 Inadequate Procedures - Normal
06 Overconfidence	19 Inadequate Procedures - Emergency
07 Underconfidence	21 Inadequate Supervision - Unit
08 Inadequate Motivation	22 Inadequate Supervision -Staff
09 Fatigue	23 Inadequate Supervision - Direct
11 Habit Interference	97 Insufficient Information

*An error may be caused by more than one system inadequacy

TABLE 3 FY84-89, ARMY AVIATION HUMAN ERROR ACCIDENTS (CLASS A-C)
TASK ERRORS CONTAINING VERIFIABLE HUMAN ERROR BY SYSTEM INADEQUACIES
IN THE 33 FIXED WING ACCIDENT CASES ANALYZED

		System Inadequacies*														
Task Errors	N	05	03	06	02	07	11	18	01	04	08	14	19	23	97	**Total**
Monitor (02)	14	6		3	1			1							6	17
Inspect (01)	9	4		1											4	9
Decide (08)	6		1	2	2	2							1			8
Control (10)	5		3		2		1		1						1	8
Communicate (11)	3	1		1											1	3
Recognize (03)	3										1	1			2	4
Misjudge (04)	2		2													2
Misinterpret (05)	1		1					1								2
Anticipate (06)	1									1				1		2
Plan (07)	1						1									1
Improvise (09)	1														1	1
Total	46	11	7	7	5	2	2	2	1	1	1	1	1	1	15	57

System Inadequacy Definitions

01 Inadequate School Training	12 Environmental Conditions
02 Inadequate Unit Training	13 Inadequate Facilities/Services
03 Inadequate Experience	14 Inadequate Design
04 Inadequate Composure	16 Inadequate Maintenance
05 Inadequate Attention	18 Inadequate Procedures - Normal
06 Overconfidence	19 Inadequate Procedures - Emergency
07 Underconfidence	21 Inadequate Supervision - Unit
08 Inadequate Motivation	22 Inadequate Supervision -Staff
09 Fatigue	23 Inadequate Supervision - Direct
11 Habit Interference	97 Insufficient Information

*An error may be caused by more than one system inadequacy

TABLE 4 FY84-89, ARMY AVIATION HUMAN ERROR ACCIDENTS (CLASS A-C) TASK ERRORS CONTAINING VERIFIABLE HUMAN ERROR BY SYSTEM INADEQUACIES IN THE TOP 15 MOST FREQUENTLY VIOLATED ATM PROCEDURES

		System Inadequacies*																			
Task Errors	N	05	06	03	02	08	18	04	23	14	09	11	21	22	07	19	12	13	01	97	**Total**
Monitor (02)	82	58	7	6	5	1		2	1	3	2		1		1	1		1		11	100
Decide (08)	49	1	14	4	7	12	3		2		1	1	1		1				1	14	62
Control (10)	30	4		13	8		2	6	2	1		1								4	41
Misjudge (04)	23		8	7	3	1	1			1				2			1	1		5	30
Inspect (01)	22	3	1			3						1								14	22
Communicate (11)	21	1	5	3	4				2					1		1				7	24
Anticipate (06)	13		7	3	2								2							1	15
Recognize (03)	11	3	1	1	1		1			1		1					1			2	12
Plan (07)	6		3	2			1							1						1	8
Misinterpret (05)	5				1		1				1									2	5
Total	262	70	46	39	31	17	9	8	7	6	4	4	4	4	2	2	2	2	1	61	319

System Inadequacy Definitions

01 Inadequate School Training	12 Environmental Conditions
02 Inadequate Unit Training	13 Inadequate Facilities/Services
03 Inadequate Experience	14 Inadequate Design
04 Inadequate Composure	16 Inadequate Maintenance
05 Inadequate Attention	18 Inadequate Procedures - Normal
06 Overconfidence	19 Inadequate Procedures - Emergency
07 Underconfidence	21 Inadequate Supervision - Unit
08 Inadequate Motivation	22 Inadequate Supervision -Staff
09 Fatigue	23 Inadequate Supervision - Direct
11 Habit Interference	97 Insufficient Information

*An error may be caused by more than one system inadequacy

APPENDIX D

COMPLETE LISTING OF THE MOST FREQUENTLY VIOLATED PROCEDURES

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Table 1 FY84-89, Army Aviation Human Error Accidents (Class A-C)

MOST FREQUENTLY VIOLATED AIRCREW TRAINING MANUAL (ATM) PROCEDURES - ROTARY WING										
ATM TASK #	TASK/JOB/ACTIVITY	FREQ	% TOTAL	TOTAL COST*	% TOTAL	FAT*	% TOTAL	INJ*	% TOTAL	AVG %
1035/2081	Terrain Flight	59	22.52%	$40,958,419	29.53%	27	51.92%	45	20.55%	31.13%
1071	Crew Coordination	23	8.78%	$11,406,841	8.22%	4	7.69%	34	15.53%	10.05%
1083	VHIRP	9	3.44%	$15,467,257	11.15%	10	19.23%	7	3.20%	9.25%
1017	Hovering Flight	33	12.60%	$15,939,653	11.49%	0	0.00%	21	9.59%	8.42%
1001	Plan VFR Flight	8	3.05%	$5,966,699	4.30%	6	11.54%	21	9.59%	7.12%
1028	VMC Approach	18	6.87%	$7,031,763	5.07%	0	0.00%	24	10.96%	5.72%
2004	Pinnacle Operations	11	4.20%	$5,591,926	4.03%	3	5.77%	15	6.85%	5.21%
1005	Preflight Inspection	20	7.63%	$13,550,589	9.77%	1	1.92%	1	0.46%	4.95%
1032	Slope Operations	13	4.96%	$2,990,359	2.16%	0	0.00%	27	12.33%	4.86%
1015	Ground Taxi	10	3.82%	$10,405,067	7.50%	0	0.00%	14	6.39%	4.43%
2016	External Load Operations	9	3.44%	$5,347,082	3.85%	1	1.92%	2	0.91%	2.53%
1053	Simulated Engine Failure	18	6.87%	$644,904	0.46%	0	0.00%	4	1.83%	2.29%
2084	Terrain Flight Approach	11	4.20%	$3,000,846	2.16%	0	0.00%	4	1.83%	2.05%
1031	Confined Area Operations	20	7.63%	$412,763	0.30%	0	0.00%	0	0.00%	1.98%
	TOTAL	**262**	**100.00%**	**$138,714,168**	**100.00%**	**52**	**100.00%**	**219**	**100.00%**	**100.00%**

*Accident data duplicated for each procedure, if more than one procedure was violated in the accident.

Total Accidents = 188
Total Accident Costs = $ 134,444,453
Total Fatalities = 49
Total Injuries = 193

Table 2 FY84-89, Army Aviation Human Error Accidents (Class A-C)

MOST FREQUENTLY VIOLATED NON-ATM PROCEDURES - ROTARY WING										
REFERENCE	TASK/JOB/ACTIVITY	FREQ	% TOTAL	TOTAL COST *	% TOTAL	FAT*	% TOTAL	INJ*	% TOTAL	AVG %
AR 95 - 1	Acrobatic Flight	6	9.09%	$4,605,688	6.37%	11	26.19%	9	13.85%	13.88%
	Cruise Flight	4	6.06%	$7,639,299	10.57%	5	11.90%	13	20.00%	12.13%
	PIC Duties	9	13.64%	$5,906,845	8.17%	0	0.00%	8	12.31%	8.53%
	Command and Supervise	1	1.52%	$1,024,352	1.42%	0	0.00%	4	6.15%	2.27%
	Flight Planning	1	1.52%	$662,100	0.92%	0	0.00%	3	4.62%	1.76%
	Instrument Approach	1	1.52%	$662,100	0.92%	0	0.00%	3	4.62%	1.76%
	Crew Selection/Scheduling	2	3.03%	$74,127	0.10%	0	0.00%	0	0.00%	0.78%
	MOC	1	1.52%	$86,901	0.12%	0	0.00%	0	0.00%	0.41%
	Mission Authority	1	1.52%	$29,698	0.04%	0	0.00%	0	0.00%	0.39%
	TOTAL	26	39.42%	$20,691,110	28.63%	16	38.09%	40	61.55%	41.91%
TC 1 - 204	Mission Planning	9	13.64%	$9,550,038	13.22%	8	19.05%	6	9.23%	13.78%
	Formation Flight	4	6.06%	$11,364,850	15.73%	5	11.90%	3	4.62%	9.58%
	Airspace Management	1	1.52%	$8,762,750	12.13%	8	19.05%	0	0.00%	8.17%
	Mast Opns - Night	1	1.52%	$1,812,158	2.51%	4	9.52%	0	0.00%	3.39%
	Crew Teamwork	5	7.58%	$1,723,238	2.38%	0	0.00%	2	3.08%	3.26%
	Light Fixation	1	1.52%	$4,739,450	6.56%	0	0.00%	3	4.62%	3.17%
	TOTAL	21	31.84%	$37,952,484	52.53%	25	59.52%	14	21.55%	41.35%
TC 1 - 201	Crew Coordination	6	9.09%	$11,648,406	16.12%	1	2.38%	2	3.08%	7.67%
	Rappelling Operations	3	4.55%	$83,910	0.12%	0	0.00%	3	4.62%	2.32%
	Hazard Information	2	3.03%	$1,106,074	1.53%	0	0.00%	3	4.62%	2.29%
	Mission Planning	2	3.03%	$277,548	0.38%	0	0.00%	3	4.62%	2.01%
	Rig External Load	1	1.52%	$126,016	0.17%	0	0.00%	0	0.00%	0.42%
	Supervise Training	1	1.52%	$126,016	0.17%	0	0.00%	0	0.00%	0.42%
	Briefing/Briefback	1	1.52%	$90,824	0.13%	0	0.00%	0	0.00%	0.41%
	Training Area Selection	1	1.52%	$78,081	0.11%	0	0.00%	0	0.00%	0.41%
	Crew Endurance	1	1.52%	$59,003	0.08%	0	0.00%	0	0.00%	0.40%
	Multi-helicopter Opns	1	1.52%	$27,112	0.04%	0	0.00%	0	0.00%	0.39%
	TOTAL	19	28.82%	$13,622,990	18.85%	1	2.38%	11	16.94 %	16.74%
	GRAND TOTAL	66		$72,266,584		42		65		

*Accident data duplicated for each procedure, if more than one procedure was violated in the accident.

Total Accidents = 51
Total Accident Cost = $70,311,962
Total Fatalities = 42
Total Injuries = 57

Table 3 FY84-89, Army Aviation Human Error Accidents (Class A-C)

MOST FREQUENTLY VIOLATED AIRCREW TRAINING MANUAL (ATM) PROCEDURES - FIXED WING										
ATM TASK #	TASK/JOB/ACTIVITY	FREQ	% TOTAL	TOTAL COST *	% TOTAL	FAT*	% TOTAL	INJ*	% TOTAL	AVG %
1027	Engine Failure, Takeoff	3	13.64%	$1,457,770	75.20%	1	100.00%	6	100.00%	72.21%
1020	Normal Landing	10	45.45%	$308,938	15.94%	0	0.00%	0	0.00%	15.35%
1007	Taxiing	6	27.27%	$66,424	3.43%	0	0.00%	0	0.00%	7.67%
1021	PAPL	3	13.64%	$105,470	5.44%	0	0.00%	0	0.00%	4.77%
	TOTAL	**22**	**100.00%**	**$1,938,602**	**100.00%**	**1**	**100.00%**	**6**	**100.00%**	**100.00%**

*Accident data duplicated for each procedure, if more than one procedure was violated in the accident.

Total Accidents = 14
Total Accident Cost = $1,938,602
Total Fatalities = 1
Total Injuries = 6

Table 4 FY84-89, Army Aviation Human Error Accidents (Class A-C)

MOST FREQUENTLY VIOLATED NON-ATM PROCEDURES - FIXED WING										
REFERENCE	**TASK/JOB/ACTIVITY**	**FREQ**	**% TOTAL**	**TOTAL COST***	**% TOTAL**	**FAT***	**% TOTAL**	**INJ***	**% TOTAL**	**AVG %**
T.O.1.c-7A-1	Manual Landing Gear									
(C7A Operators Manual)	Extension	1	20.00%	$336,182	25.90%	0	0.00%	2	50.00%	31.97%
	Check Landing Gear									
	Position	1	20.00%	$336,182	25.90%	0	0.00%	2	50.00%	31.97%
	TOTAL	**2**	**40.00%**	**$672,364**	**51.80%**	**0**	**0.00%**	**4**	**100.00%**	**63.94%**
TM 55-1510-209-10	Fuel Management	1	20.00%	$587,004	45.22%	0	0.00%	0	0.00%	21.74%
(U21 Operators Manual)	Check Propeller RPM	1	20.00%	$20,096	1.55%	0	0.00%	0	0.00%	7.18%
	Check Oil Filler Cap	1	20.00%	$18,640	1.44%	0	0.00%	0	0.00%	7.15%
	TOTAL	**3**	**60.00%**	**$625,740**	**48.21%**	**0**	**0.00%**	**0**	**0.00%**	**36.07%**
	GRAND TOTAL	**5**		**$1,298,104**		**0**		**4**		

*Accident data duplicated for each procedure, if more than one procedure was violated in the accident.

Total Accidents = 4
Total Accident Cost = $1,298,104
Total Fatalities = 0
Total Injuries = 2

APPENDIX E

DISTRIBUTION OF AIRCRAFT TYPES AND NVDS BY ATM TASK
FOR THE TOP 15 ROTARY WING ATM PROCEDURES

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TABLE 1 FY84-89, ARMY AVIATION HUMAN ERROR ACCIDENTS (CLASS A-C)
TOP 15 MOST FREQUENTLY VIOLATED ROTARY WING ATM TASKS
Type Aircraft by ATM Task

	ATM TASK															
Type Aircraft	1035/ 2081	1017	1071	1005	1031	1028	1053	1032	2004	2084	1015	1083	2016	1001	N	% Total
UH-1	4	13	9	4	11	11	3	8	11	4		4		4	86	33
OH-58	15	10	6	1	5	3	7	2				1		2	52	20
AH-1	22	2	2	7	3		1	2				3		1	43	16
UH-60	9	4	5	3		3				3	8		1	1	37	14
CH-47	2	2		4		1		1		4	2		7		23	9
OH-6	1		1				6								8	3
AH-64	3	1		1	1							1			7	3
MH-6	3						1								4	2
AH-6		1													1	<1
CH-54													1		1	<1
Totals*	59	33	23	20	20	18	18	13	11	11	10	9	9	8	262	100

ATM Task Definitions

1035/2081 Perform Terrain Flight
1017 Perform Hovering Flight
1071 Perform as a Crewmember
1005 Perform Preflight Inspection
1031 Perform Confined Area Operations
1028 Perform VMC Approach
1053 Perform Simulated Engine Failure at Altitude
1032 Perform Slope Operations
2084 Perform Terrain Flight Approach
2004 Perform Pinnacle or Ridgeline Operation
1015 Perform Ground Taxi
1083 Perform or Describe VHIRP
2016 Perform External Load Operations
1001 Plan a VFR Flight

*Totals listed by decreasing frequency of occurrence.

TABLE 2 FY84-89, ARMY AVIATION HUMAN ERROR ACCIDENTS (CLASS A-C) TOP 15 MOST FREQUENTLY VIOLATED ROTARY WING ATM TASKS NVD Cases by ATM Task Violations

		ATM TASK								
NVD	N*	1035/2081	1017	1071	1083	2084	1015	1028	2016	1031
ANPVS-5	16	4	4	1	3		3		1	
ANVIS-6	15	2	1	5	1	4		2		
FLIR	3	1	1							1
PNVS	1				1					
***Totals**	35	7	6	6	5	4	3	2	1	1

ATM Task Definitions

1035/2081 Perform Terrain Flight
1017 Perform Hovering Flight
1071 Perform as a Crewmember
1083 Perform or Describe VHIRP
2084 Perform Terrain Flight Approach
1015 Perform Ground Taxi
1028 Perform VMC Approach
2016 Perform External Load Operations
1031 Perform Confined Area Operations

*Totals listed by decreasing frequency of occurrence.